NASA/TM—2000–209891, Vol. 192

Te Report Se on the
B osystem-A sphere Study (BOREAS)

ll and Andrea Papagno, Editors

192

AS TF-1 SSA-OA Soil
a

Z. Chen, and Z. Nesic

nautics and
stration

ce Flight Center
ryland 20771

Octo

The NASA STI Program Office ... in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA's scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

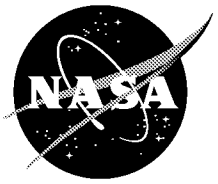
- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA's counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.
- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.
- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.
- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and mission, often concerned with subjects having substantial public interest.
- TECHNICAL TRANSLATION. English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services that complement the STI Program Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results . . . even providing videos.

For more information about the NASA STI Program Office, see the following:

- Access the NASA STI Program Home Page at http://www.sti.nasa.gov/STI-homepage.html
- E-mail your question via the Internet to help@sti.nasa.gov
- Fax your question to the NASA Access Help Desk at (301) 621-0134
- Telephone the NASA Access Help Desk at (301) 621-0390
- Write to:
  NASA Access Help Desk
  NASA Center for AeroSpace Information
  7121 Standard Drive
  Hanover, MD 21076-1320

NASA/TM—2000–209891, Vol. 192



Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Andrea Papagno, Editors

Volume 192

BOREAS TF-1 SSA-OA Soil Characteristics Data

T. Andrew Black, Z. Chen, and Zoran Nesic
University of British Columbia, Vancouver

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

October 2000

Available from:

NASA Center for AeroSpace Information
7121 Standard Drive
Hanover, MD 21076-1320
Price Code: A17

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Price Code: A10

BOREAS TF-1 SSA-OA Soil Characteristics Data

T. Andrew Black, Z. Chen, Zoran Nesic

Summary

The BOREAS TF-1 team collected several data sets in support of its efforts to characterize and interpret soil information at the SSA-OA tower site in 1994 as part of BOREAS. Data sets collected include soil respiration, temperature, moisture, and gravimetric data. The data are stored in tabular ASCII format.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-01 SSA-OA Soil Characteristics Data

1.2 Data Set Introduction

Tower Flux (TF)-01 collected measurements of soil respiration, temperature, moisture, and gravimetric data in an effort to characterize the soil at the Southern Study Area (SSA) Old Aspen (OA) tower site in 1994 as part of the BOReal Ecosystem-Atmosphere Study (BOREAS).

1.3 Objective/Purpose

The objectives of this research were to:

- Determine the efflux of CO_2 from the soil using the closed-chamber method and to investigate the flow of C and N through the litter/soil system (Paul Voroney and Craig Russell, University of Guelph).
- Determine the course of soil moisture content during the year using gravimetric (University of British Columbia) and Time Domain Reflectometry (TDR) (University of Guelph and University of British Columbia).

1.4 Summary of Parameters

The soil respiration flux data contain measurements of mean daytime soil CO_2 flux, mean daytime soil temperature, mean daytime chamber air temperature, and mean daytime chamber relative humidity.

The CO_2 concentration data include measurements of the CO_2 concentration in the humus soil layer at 62 mm below the surface of the soil and in the surface mineral soil layer at 15 cm below the soil surface.

The soil temperature data contain measurements of the mean daily soil temperature at depths of 50 mm, 100 mm, 200 mm, 500 mm, and 1 m.

The soil gravimetric data contain measurements of mean gravimetric and mean volumetric soil moisture and mean bulk density taken at the following soil depths: Litter-Fibric-Humus (LFH) organic soil horizons, 0-3 cm, 3-6 cm and 6-10 cm, and 0-15 cm and 15-30 cm.

The soil moisture data contain measurements of soil moisture in the mid-humus, mineral soil, and submineral soil layers taken at locations A, B, C, and D at the SSA-OA site using surface probes. Soil moisture was also measured at depths ranging from 0 cm to 120 cm in increments of 15 cm using depth probes read by Tektronix Cable Tester and Moisture Point (Gabel Corp.) instruments.

The soil moisture summary data contain means, variation coefficients, and the number of observations of the soil moisture data as discussed above.

1.5 Discussion

TF-01 collected measurements of soil respiration, temperature, moisture, and gravimetric data in an effort to characterize the soil at the SSA-OA tower site in 1994 as part of BOREAS. The closed chamber was the primary method of measuring soil CO_2 efflux. The data from this method were used to obtain the seasonal pattern of soil CO_2 efflux. The open chamber method was used over a 3-week period late in the growing season to determine the diurnal patterns of soil CO_2 efflux. A soil temperature profile was taken at depths of 2, 5, 10, 20, 50, and 100 cm using CSI direct-burial copper-constantan thermocouples. Gravimetric measurements of soil water content of the surface layers (0-3, 3-6, and 6-10 cm) were made every 2-3 days. In addition, the TDR technique (Hook and Livingston, 1996) was also used. Two probes consisting of three stainless steel roads (3 mm in diameter, 30 cm long, and 2 cm apart) were positioned horizontally at 8-cm (organic layer) and 15-cm (mineral layer) depths. Five 120-cm segmented rods (two thin stainless steel strips 1.2 cm wide and 1.5 cm apart bonded by an epoxy resin layer) were installed to measure average water content in 15-cm (0- to 30-cm depth) and 30-cm layers (30- to 120-cm depth). The TDR rods near hut B (University of British Columbia) were mainly read using the Tektronix Cable Tester in hut B with signal cables (about 30 m long) extending out to the TDR rods. A small manually weighed lysimeter (15 cm diameter x 15 cm deep) was operated for 15 days in July and August of 1994 to determine the magnitude of evaporation from the soil.

1.6 Related Data Sets

BOREAS HYD-06 Moss/Humus Moisture Data
BOREAS TE-01 Soils Data Over the SSA Tower Sites in Raster Format
BOREAS TF-01 SSA-OA Tower Flux, Meteorological, and Soil Temperature Data
BOREAS TF-01 SSA-OA Understory Flux, Meteorological, and Soil Temperature Data
BOREAS TF-02 SSA-OA Tower Flux, Meteorological, and Precipitation Data
BOREAS TGB-01 Soil CH4 And CO2 Profile Data From NSA Tower Sites
BOREAS TGB-12 Soil Carbon Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. T. Andy Black, Professor

2.2 Title of Investigation

Boreal Forest Atmosphere Interactions: Exchanges of Energy, Water Vapor and Trace Gases (SSA-OA)

2.3 Contact Information

Contact 1:
Mr. Zoran Nesic
University of British Columbia
Department of Soil Science
2357 Main Mall Rm. 139
Vancouver, BC V6T 1Z4
CANADA
(604) 822-3479
(604) 822-5654 (Lab)
(604) 822-8639 (fax)
NESIC@PPC.UBC.CA

Contact 2:
Prof. T. Andy Black
University of British Columbia
Department of Soil Science
2357 Main Mall Rm. 139
Vancouver, BC V6T 1Z4
CANADA
(604) 822-2730
(604) 822-8639 (fax)
ablack@unixg.ubc.ca

Contact 3:
Andrea Papagno
Raytheon ITSS
NASA GSFC
Code 923.4
Greenbelt, MD 20771
(301) 286-3134
(301) 286-0239 (fax)
Andrea.Papagno@gsfc.nasa.gov

3. Theory of Measurements

Three methods were employed to estimate soil CO_2 efflux. The first method used Fick's law, which required estimates of soil gas (CO_2) diffusivity and measured CO_2 concentration gradients. See Section 18 for a definition of Fick's law. The second method used the accumulation of gas within a chamber placed over the soil surface (static closed chamber). The third method is the steady-state or dynamic open chamber. In this method, flow rate through the chamber and the difference in gas concentration between the inlet and outlet of the chamber are measured. The CO_2 efflux is given by the

product of the concentration difference and flow rate. These estimates were compared with nighttime eddy covariance CO_2 fluxes (Russell et al., 1998).

TDR relies on the different dielectric constants for water and air to detect the reflection of a high-frequency electromagnetic pulse sent down a transmission line or wave guide, with volume water content related to the apparent dielectric constant by a model described by Hook and Livingston (1996).

4. Equipment

4.1 Sensor/Instrument Description

4.1.1 Collection Environment

Soil respiration, soil CO_2 concentrations, gravimetric, and soil moisture data were collected by TF-01 from the ground or from the soil respiration boardwalk at the SSA-OA site. Soil respiration was measured with a LI-COR 6200 portable photosynthesis unit from the 6000-09 soil respiration chamber. Data are daytime averages of daily observations recorded between 10 a.m. and 4 p.m. local time. Soil CO_2 concentrations were collected in evacuated containers from sampling lines in the surface soil. Data are daily averages of half-hour observations. Data for 0.05, 0.1, and 0.2 m below the soil surface are averages of three probes (one close to tower, i.e., University of British Columbia probes, and two along soil respiration boardwalk, i.e., University of Guelph probes). Data for 0.5 and 1.0 m were recorded from one set of probes close to the SSA-OA flux tower. Gravimetric data were derived from the weight loss of wet soil after 72 hours in an oven at 60 °C for organic soil samples and at 105 °C for mineral soil samples.

Soil moisture was determined from the time delay along probe transmission lines, i.e., TDR. Time delays were converted to volumetric moisture contents using the Hook and Livingston (1996) equation where the ratio of the time delay in dry soil to that in air was 1.2 for organic soil and 1.55 for mineral soil. Two types of TDR probes were used. Surface probes consisted of three parallel 0.3-m lengths of stainless steel welding rod 2 cm apart. These were inserted into surface soil layers, i.e., 0 to 0.3 m in a horizontal orientation, and connected to a Tektronix cable tester via lengths of coaxial cable. Depth probes were purchased from Environmental Sensors, Inc., along with a MoisturePoint TDR analysis instrument. The depth probes could be read by both Tektronix and MoisturePoint instruments. The depth probes were 4 feet in length and could estimate soil moisture content along five segments (6", 6", 1', 1', 1'). These probes were inserted vertically into the forest floor.

4.1.2 Source/Platform

Soil respiration, soil CO_2 concentrations, gravimetric, and soil moisture data were collected by TF-01 from the ground or from the soil respiration boardwalk at the SSA-OA site.

4.1.3 Source/Platform Mission Objectives

The general objective was to study carbon dioxide and water vapor exchange between the forest and atmosphere at SSA-OA. Specific objectives were to:

- Measure the fluxes of sensible heat, H_2O, and CO_2 above the aspen stand throughout the year.
- Obtain from the CO_2 flux data estimates of gross photosynthesis and respiration.
- Determine the contribution of the hazelnut understory to net ecosystem productivity (NEP).
- Determine the effects of environmental factors on stand evapotranspiration (E) and NEP.
- Take part in the development of procedures for scaling up component fluxes to the stand level.
- Study the processes controlling turbulent transfer of H_2O and CO_2 within the stand.
- Take part in the evaluation of methods of estimating nocturnal CO_2 in and above the stand.

4.1.4 Key Variables

Mean soil CO_2 flux, soil CO_2 concentration, mean volumetric soil moisture, mean soil temperature, mean soil bulk density, mean gravimetric soil moisture, mean TDR soil moisture, and TDR soil moisture.

4.1.5 Principles of Operation

The principles of operation of most of the instruments can be found in Pearcy et al., 1991, and Fritschen and Gay, 1979. (See Sections 3 and 4.1.1 also.)

4.1.6 Sensor/Instrument Measurement Geometry

Closed chamber: Inner diameter 9.55 cm and height 14.60 cm. Open chamber: Collar inner diameter 20 cm and collar height 10 cm (Russell et al., 1998). TDR: 120-cm segmented (two 15-cm segments and three 30-cm segments) rods (two stainless steel strips 2 cm apart separated by epoxy) with shorting diodes (Hook et al., 1992).

4.1.7 Manufacturer of Sensor/Instrument

Cable Length Tester (model 1502B & C)
Tektronix, Inc
26600 SW Parkway
Wilsonville, OR 97070 USA
800-TEK-WIDE

Data logging system 21x, CR10
Campbell Scientific
P.O. Box 551
Logan, UT 84321 USA
(801) 753-2342
(801) 752-3268 (fax)

Field (110 VAC) drying oven

LI-COR 6200 portable photosynthesis unit and 6000-09 soil respiration chamber
LI-COR, Inc.
P.O. Box 4425/4421
Superior Street
Lincoln, NE 68504
(303) 499-1701
(303) 499-1767 (fax)

Soil temperature (burial) Campbell Thermocouple
Copper-constantan thermocouple
Campbell Scientific
P.O. Box 551
Logan, UT 84321 USA
(801) 753-2342
(801) 752-3268 (fax)

Thermal conductivity gas chromatography instrumentation (University of Guelph)
Datalogger model 21X
Campbell Scientific, Inc. (CSI)
P.O. Box 551
Logan, UT 84321 USA
(801) 753-234
(801) 752-3268 (fax)

TDR
TDR depth (segmented) probes and Moisture Point Depth Probe Reader
G.S. Gabel & Associates Ltd.
100 - 4243 Glanford Avenue
Victoria, British Columbia, Canada V8Z 4B9
(250) 479-6588 (general)
(800) 799-6324 (within North America only)
(250) 479-1412 (fax)
info@esica.com http://www.esica.com/

TDR surface probes
(three stainless steel rods and two diodes)
(homemade)

4.2 Calibration

4.2.1 Specifications

The TDR calibration was done in the field using gravimetric sampling and a bulk density profile. Chamber calibration was done by using calibration gases used to calibrate the eddy correlation/CO_2 profile analyzers. Analysis was performed at the Atmospheric Environment Service (AES) Headquarters, Downsview, Ontario, Canada, using a standard traceable to a Scripps analysis in 1993.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

- Soil chamber Infrared Gas Analyzer (IRGA): 3 times during 1994 growing season
- TDR: Organic surface layer: calibrated using gravimetric samples taken every 2-3 days in 1994 (Blanken et al. 1997).
- TDR: Mineral layers: calibrated using gravimetric profiles (2) in 1994

4.2.3 Other Calibration Information

Not applicable.

5. Data Acquisition Methods

Soil respiration (CO_2 efflux) was measured with a LI-COR 6200 portable photosynthesis unit from the 6000-09 soil respiration chamber. This unit also facilitates measurements of chamber temperature, relative humidity, and soil temperature adjacent to the chamber. Data are daytime averages of daily observations recorded between 10 a.m. and 4 p.m. SSA local time. Soil CO_2 concentrations were collected in evacuated containers from sampling lines in the surface soil. These samples were analyzed for CO_2 concentration by thermal conductivity gas chromatography. Soil temperatures were measured with thermocouples attached to a Campbell 21X datalogger. Data are daily averages of half-hour observations. Data for 0.05, 0.1, and 0.2 m are averages of three probes (one close to tower, i.e., University of British Columbia probes, and two along soil respiration boardwalk, i.e., University of Guelph probes). Data for 0.5 and 1.0 m were recorded from one set of probes close to the tower. Gravimetric data were derived from the weight loss of wet soil after 72 hours in an oven at 60 °C for organic soil samples and at 105 °C for mineral soil samples. Soil moisture was determined from the time delay along probe transmission lines, i.e., TDR. Time delays were converted to volumetric moisture contents using the Hook and Livingston (1992) equation where the ratio of the time delay in dry soil to that in air was 1.2 for organic soil and 1.55 for mineral soil. Two types of TDR probes were used, surface and depth. Surface probes consisted of three parallel 0.3-m lengths of stainless

steel welding rod 2 cm apart. These were inserted into surface soil layers, i.e., 0 to 0.3 m in a horizontal orientation, and connected to a Tektronix cable tester via lengths of coaxial cable. TDR depth probes and Moisture Point electronics were purchased from Gabel Corp. The depth probes could also be read by the Tektronix cable tester. The depth probes were 4 feet in length and could estimate soil moisture content along five segments (6 inches, 6 inches, 1 foot, 1 foot, 1 foot). These probes were inserted vertically into the forest floor. Extensive details of methods and equipment is outlined in the publications (i.e., Russell and Voroney, 1998; Russell et al., 1998; Black et al., 1996; Chen et al., 1999).

For the main flux system, all raw data were recorded using PC computer systems with backup tape drives. Half-hour fluxes were calculated online. For other measurements, all those data were recorded by data loggers (model 21X, Campbell Scientific, Inc., Logan, UT), which were networked together (using the model MD-9 network interface) along with the main system. Every 3 hours, this network automatically transferred (using pc ANYWHERE, Symantec Corp.) all data from the loggers to a network computer. This computer was accessed from our laboratory at University of British Columbia through a communication system, which comprised a modem, cellular phone, and Yagi antenna at the site, and a phone and modem in the laboratory. The Yagi antenna was mounted above the trees and the cellular phone was housed in a thermostatically controlled box near the antenna. At midnight the site computer compressed the previous 24 hours of half-hour flux data, called the laboratory, and in 3 minutes transferred (using Kermit) the compressed data to the laboratory computer.

6. Observations

6.1 Data Notes

None given.

6.2 Field Notes

None given.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The SSA measurement site and associated North American Datum of 1983 (NAD83) coordinates are:

- SSA-OA, site id C3B7T, Lat/Long: 53.62889° N, 106.19779° W, UTM Zone 13, N: 5942899.9, E: 420790.5.

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

The data are point measurements at the given location.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
Measurement occurred between 10 a.m. and 4 p.m. SSA local time.

7.2.2 Temporal Coverage Map
None given.

7.2.3 Temporal Resolution
None given.

7.3 Data Characteristics

7.3.1 Parameter/Variable
The parameters contained in the data files on the CD-ROM are:

TF01_SOIL_CO2_CONC

```
         Column Name
------------------------------
SITE_NAME
SUB_SITE
DATE_OBS
START_TIME
END_TIME
SOIL_DEPTH
SOIL_LAYER
MEAN_CO2_CONC
COEFF_VAR_SOIL_CO2_CONC
CRTFCN_CODE
REVISION_DATE
```

TF01_SOIL_MOIST_GRAV

```
         Column Name
------------------------------
SITE_NAME
SUB_SITE
DATE_OBS
SOIL_DEPTH_DESCR
MEAN_GRAV_SOIL_MOIST
MEAN_BULK_DENSITY
MEAN_VOL_SOIL_MOIST
CRTFCN_CODE
REVISION_DATE
```

TF01_SOIL_MOIST_SUMMARY

```
         Column Name
------------------------------
SITE_NAME
SUB_SITE
DATE_OBS
SOIL_DEPTH_DESCR
SENSOR_TYPE
NUM_OBS
MEAN_VOL_SOIL_MOIST
```

COEFF_VAR_VOL_SOIL_MOIST
CRTFCN_CODE
REVISION_DATE

TF01_SOIL_MOIST_VOL

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
SOIL_DEPTH_DESCR
LOCATION_ID
SENSOR_TYPE
SENSOR_ID
VOL_SOIL_MOIST
CRTFCN_CODE
REVISION_DATE

TF01_SOIL_RESP_FLUX

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
START_TIME
END_TIME
NUM_OBS
NUM_SITES
MEAN_SOIL_CO2_FLUX
COEFF_VAR_SOIL_CO2_FLUX
MEAN_SOIL_TEMP_0_10CM
MEAN_AIR_TEMP_CHAMBER
MEAN_REL_HUM_CHAMBER
CRTFCN_CODE
REVISION_DATE

TF01_SOIL_TEMP

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
SOIL_DEPTH
MEAN_SOIL_TEMP
CRTFCN_CODE
REVISION_DATE

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

TF01_SOIL_CO2_CONC

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
START_TIME	The starting Greenwich Mean Time (GMT) for the data collected.
END_TIME	The ending Greenwich Mean Time (GMT) for the data collected.
SOIL_DEPTH	The depth below the soil surface at which the measurement was taken.
SOIL_LAYER	The soil layer in which the measurement was taken.
MEAN_CO2_CONC	The mean carbon dioxide concentration.
COEFF_VAR_SOIL_CO2_CONC	The coefficient of variation for the soil CO2 concentration data.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

TF01_SOIL_MOIST_GRAV

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.

DATE_OBS	The date on which the data were collected.
SOIL_DEPTH_DESCR	The soil depth range or the name of the soil surface horizon where the measurements were taken. See documentation for a description of the soil horizons.
MEAN_GRAV_SOIL_MOIST	The mean percentage of gravimetric moisture present in the soil at this depth range or horizon area.
MEAN_BULK_DENSITY	The mean bulk density of the soil at this depth range or horizon area.
MEAN_VOL_SOIL_MOIST	The mean percentage of volumetric moisture present in the soil at this depth range or horizon area.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

TF01_SOIL_MOIST_SUMMARY

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
SOIL_DEPTH_DESCR	The soil depth range or the name of the soil surface horizon where the measurements were taken. See documentation for a description of the soil horizons.
SENSOR_TYPE	The type of sensor used to make the measurements.
NUM_OBS	Number of observations of the given sample used to calculate given values.
MEAN_VOL_SOIL_MOIST	The mean percentage of volumetric moisture present in the soil at this depth range or horizon area.
COEFF_VAR_VOL_SOIL_MOIST	The coefficient of variation for the volumetric (TDR) soil moisture data.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

TF01_SOIL_MOIST_VOL

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
SOIL_DEPTH_DESCR	The soil depth range or the name of the soil surface horizon where the measurements were taken. See documentation for a description of the soil horizons.
LOCATION_ID	The location within the site where the measurement was taken.
SENSOR_TYPE	The type of sensor used to make the measurements.
SENSOR_ID	The identifier given to the sensor/instrument that collected the data.
VOL_SOIL_MOIST	Contains the percent volumetric soil moisture value.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

TF01_SOIL_RESP_FLUX

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
START_TIME	The starting Greenwich Mean Time (GMT) for the data collected.

END_TIME	The ending Greenwich Mean Time (GMT) for the data collected.
NUM_OBS	Number of observations of the given sample used to calculate given values.
NUM_SITES	The number of sites measured.
MEAN_SOIL_CO2_FLUX	The mean of the soil CO2 flux.
COEFF_VAR_SOIL_CO2_FLUX	The coefficient of variation for the soil CO2 flux data.
MEAN_SOIL_TEMP_0_10CM	The mean soil temperature for 0 to 10 centimeter depth collected adjacent to the soil CO2 flux chamber.
MEAN_AIR_TEMP_CHAMBER	The mean air temperature in the chamber.
MEAN_REL_HUM_CHAMBER	The mean relative humidity inside the measurement chamber.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

TF01_SOIL_TEMP

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
SOIL_DEPTH	The depth below the soil surface at which the measurement was taken.
MEAN_SOIL_TEMP	The mean soil temperature.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

TF01_SOIL_CO2_CONC

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
START_TIME	[HHMM GMT]
END_TIME	[HHMM GMT]
SOIL_DEPTH	[millimeters]
SOIL_LAYER	[none]
MEAN_CO2_CONC	[micromoles CO2][mole air^-1]
COEFF_VAR_SOIL_CO2_CONC	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

TF01_SOIL_MOIST_GRAV

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH_DESCR	[none]
MEAN_GRAV_SOIL_MOIST	[percent]
MEAN_BULK_DENSITY	[kilograms][meter^-3]
MEAN_VOL_SOIL_MOIST	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

TF01_SOIL_MOIST_SUMMARY

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH_DESCR	[none]
SENSOR_TYPE	[none]
NUM_OBS	[counts]
MEAN_VOL_SOIL_MOIST	[percent]
COEFF_VAR_VOL_SOIL_MOIST	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

TF01_SOIL_MOIST_VOL

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH_DESCR	[none]
LOCATION_ID	[none]
SENSOR_TYPE	[none]

SENSOR_ID	[none]
VOL_SOIL_MOIST	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

TF01_SOIL_RESP_FLUX

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
START_TIME	[HHMM GMT]
END_TIME	[HHMM GMT]
NUM_OBS	[counts]
NUM_SITES	[count]
MEAN_SOIL_CO2_FLUX	[micromoles CO2][meters^-2][second^-1]
COEFF_VAR_SOIL_CO2_FLUX	[percent]
MEAN_SOIL_TEMP_0_10CM	[degrees Celsius]
MEAN_AIR_TEMP_CHAMBER	[degrees Celsius]
MEAN_REL_HUM_CHAMBER	[percent]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

TF01_SOIL_TEMP

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
SOIL_DEPTH	[millimeters]
MEAN_SOIL_TEMP	[degrees Celsius]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

The source of the parameter values contained in the data files on the CD-ROM are:

TF01_SOIL_CO2_CONC

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
START_TIME	[Human Observer]
END_TIME	[Human Observer]
SOIL_DEPTH	[Human Observer]
SOIL_LAYER	[Human Observer]
MEAN_CO2_CONC	[Laboratory Equipment]
COEFF_VAR_SOIL_CO2_CONC	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

TF01_SOIL_MOIST_GRAV

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH_DESCR	[Human Observer]
MEAN_GRAV_SOIL_MOIST	[Laboratory Equipment]
MEAN_BULK_DENSITY	[Laboratory Equipment]
MEAN_VOL_SOIL_MOIST	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

TF01_SOIL_MOIST_SUMMARY

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH_DESCR	[Human Observer]
SENSOR_TYPE	[Human Observer]
NUM_OBS	[Human Observer]
MEAN_VOL_SOIL_MOIST	[Laboratory Equipment]
COEFF_VAR_VOL_SOIL_MOIST	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

TF01_SOIL_MOIST_VOL

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH_DESCR	[Human Observer]
LOCATION_ID	[Human Observer]
SENSOR_TYPE	[Human Observer]
SENSOR_ID	[Human Observer]
VOL_SOIL_MOIST	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

TF01_SOIL_RESP_FLUX

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
START_TIME	[Human Observer]
END_TIME	[Human Observer]
NUM_OBS	[Human Observer]
NUM_SITES	[Human Observer]
MEAN_SOIL_CO2_FLUX	[Laboratory Equipment]
COEFF_VAR_SOIL_CO2_FLUX	[Laboratory Equipment]
MEAN_SOIL_TEMP_0_10CM	[Laboratory Equipment]

MEAN_AIR_TEMP_CHAMBER	[Laboratory Equipment]
MEAN_REL_HUM_CHAMBER	[Laboratory Equipment]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

TF01_SOIL_TEMP

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
DATE_OBS	[Human Observer]
SOIL_DEPTH	[Human Observer]
MEAN_SOIL_TEMP	[Thermometer]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

TF01_SOIL_CO2_CONC

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9OA-FLXTR	SSA-9OA-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	25-MAY-94	18-SEP-94	None	None	None	None
START_TIME	1600	1600	None	None	None	None
END_TIME	2200	2200	None	None	None	None
SOIL_DEPTH	62	150	None	None	None	None
SOIL_LAYER	N/A	N/A	None	None	None	None
MEAN_CO2_CONC	813.53	7674.1	None	None	None	None
COEFF_VAR_SOIL_CO2_CONC	12.06818	56.84175	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	14-SEP-99	14-SEP-99	None	None	None	None

TF01_SOIL__MOIST_GRAV

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9OA-FLXTR	SSA-9OA-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	13-MAY-94	19-SEP-94	None	None	None	None
SOIL_DEPTH_DESCR	N/A	N/A	None	None	None	None
MEAN_GRAV_SOIL_MOIST	4.827254	248.61	None	None	None	None
MEAN_BULK_DENSITY	108	1500	None	None	None	None
MEAN_VOL_SOIL_MOIST	5.985795	41.2	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	18-AUG-99	18-AUG-99	None	None	None	None

TF01_SOIL_MOIST_SUMMARY

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9OA-FLXTR	SSA-9OA-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	02-FEB-94	26-NOV-94	None	None	None	None
SOIL_DEPTH_DESCR	N/A	N/A	None	None	None	None
SENSOR_TYPE	N/A	N/A	None	None	None	None
NUM_OBS	1	6	-999	None	None	None
MEAN_VOL_SOIL_MOIST	1	67	-999	None	None	None
COEFF_VAR_VOL_SOIL_MOIST	0	135.4253	-999	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	03-SEP-99	03-SEP-99	None	None	None	None

TF01_SOIL_MOIST_VOL

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9OA-FLXTR	SSA-9OA-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	02-FEB-94	26-NOV-94	None	None	None	None
SOIL_DEPTH_DESCR	N/A	N/A	None	None	None	None
LOCATION_ID	A	D	None	None	None	Blank
SENSOR_TYPE	N/A	N/A	None	None	None	None
SENSOR_ID	N/A	N/A	None	None	None	Blank
VOL_SOIL_MOIST	-4	67	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	02-SEP-99	02-SEP-99	None	None	None	None

TF01_SOIL_RESP_FLUX

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9OA-FLXTR	SSA-9OA-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	16-APR-94	24-SEP-94	None	None	None	None
START_TIME	1600	1600	None	None	None	None
END_TIME	2200	2200	None	None	None	None
NUM_OBS	5	36	None	None	None	None
NUM_SITES	3	24	None	None	None	None
MEAN_SOIL_CO2_FLUX	.000618	.0093454	None	None	None	None
COEFF_VAR_SOIL_CO2_FLUX	5.429534	73.7449	None	None	None	None
MEAN_SOIL_TEMP_0_10CM	.489444	16.73333	None	None	None	None
MEAN_AIR_TEMP_CHAMBER	8.9	30.6	None	None	None	None

MEAN_REL_HUM_CHAMBER	8.26	98.4	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	02-SEP-99	02-SEP-99	None	None	None	None

TF01_SOIL_TEMP

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-9OA-FLXTR	SSA-9OA-FLXTR	None	None	None	None
SUB_SITE	9TF01-SOI01	9TF01-SOI01	None	None	None	None
DATE_OBS	01-APR-94	18-SEP-94	None	None	None	None
SOIL_DEPTH	50	1000	None	None	None	None
MEAN_SOIL_TEMP	-.2546	15.615	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	07-SEP-99	07-SEP-99	None	None	None	None

Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.
Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.
Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined that the parameter value was below the detection limit of the instrumentation.
Data Not Cllctd -- This value indicates that no attempt was made to determine the parameter value. This usually indicates that BORIS combined several similar but not identical data sets into the same data base table but this particular science team did not measure that parameter.
Blank -- Indicates that blank spaces are used to denote that type of value.
N/A -- Indicates that the value is not applicable to the respective column.
None -- Indicates that no values of that sort were found in the column.

7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

TF01_SOIL_CO2_CONC

```
SITE_NAME,SUB_SITE,DATE_OBS,START_TIME,END_TIME,SOIL_DEPTH,SOIL_LAYER,
MEAN_CO2_CONC,COEFF_VAR_SOIL_CO2_CONC,CRTFCN_CODE,REVISION_DATE
'SSA-9OA-FLXTR','9TF01-SOI01',25-MAY-94,1600,2200,62.0,'MID HUMUS',934.11,
30.1483,'CPI',14-SEP-99
'SSA-9OA-FLXTR','9TF01-SOI01',25-MAY-94,1600,2200,150.0,'SURFACE MINERAL SOIL',
1684.26,31.01604,'CPI',14-SEP-99
```

TF01_SOIL_MOIST_GRAV

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH_DESCR,MEAN_GRAV_SOIL_MOIST,
MEAN_BULK_DENSITYMEAN_VOL_SOIL_MOIST,CRTFCN_CODE,REVISION_DATE
'SSA-9OA-FLXTR','9TF01-SOI01',13-MAY-94,'0_3',217.19,108,23.6,'CPI',18-AUG-99
'SSA-9OA-FLXTR','9TF01-SOI01',13-MAY-94,'3_6',140.98,182,25.6,'CPI',18-AUG-99
```

TF01_SOIL_MOIST_SUMMARY

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH_DESCR,SENSOR_TYPE,NUM_OBS,
MEAN_VOL_SOIL_MOIST,COEFF_VAR_VOL_SOIL_MOIST,CRTFCN_CODE,REVISION_DATE
'SSA-9OA-FLXTR','9TF01-SOI01',02-FEB-94,'MID HUMUS','SURFACE PROBE',1,8.0,0.0,
'CPI',03-SEP-99
'SSA-9OA-FLXTR','9TF01-SOI01',02-FEB-94,'15 CM','SURFACE PROBE',1,15.0,0.0,
'CPI',03-SEP-99
```

TF01_SOIL_MOIST_VOL

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH_DESCR,LOCATION_ID,SENSOR_TYPE,SENSOR_ID,
VOL_SOIL_MOIST,CRTFCN_CODE,REVISION_DATE
'SSA-9OA-FLXTR','9TF01-SOI01',02-FEB-94,'8 CM','D','SURFACE PROBE','',8.0,'CPI',
02-SEP-99
'SSA-9OA-FLXTR','9TF01-SOI01',02-FEB-94,'SURFACE MINERAL SOIL (15 CM)','D',
'SURFACE PROBE','',15.0,'CPI',02-SEP-99
```

TF01_SOIL_RESP_FLUX

```
SITE_NAME,SUB_SITE,DATE_OBS,START_TIME,END_TIME,NUM_OBS,NUM_SITES,
MEAN_SOIL_CO2_FLUX,COEFF_VAR_SOIL_CO2_FLUX,MEAN_SOIL_TEMP_0_10CM,
MEAN_AIR_TEMP_CHAMBER,MEAN_REL_HUM_CHAMBER,CRTFCN_CODE,REVISION_DATE
'SSA-9OA-FLXTR','9TF01-SOI01',16-APR-94,1600,2200,5,5,.0007793,35.3695,.5,12.0,
48.0,'CPI',02-SEP-99
'SSA-9OA-FLXTR','9TF01-SOI01',22-APR-94,1600,2200,24,24,.0013687,36.60205,
.66875,21.3,46.33333,'CPI',02-SEP-99
```

TF01_SOIL_TEMP

```
SITE_NAME,SUB_SITE,DATE_OBS,SOIL_DEPTH,MEAN_SOIL_TEMP,CRTFCN_CODE,REVISION_DATE
'SSA-9OA-FLXTR','9TF01-SOI01',01-APR-94,50.0,-.0469,'CPI',07-SEP-99
'SSA-9OA-FLXTR','9TF01-SOI01',01-APR-94,100.0,-.0923,'CPI',07-SEP-99
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was the data collected at a given site on a given date.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms

None given.

9.2 Data Processing Sequence

None given.

9.2.1 Processing Steps

None given.

9.2.2 Processing Changes

None given.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

None given.

9.3.2 Calculated Variables

None given.

9.4 Graphs and Plots

None given.

10. Errors

10.1 Sources of Error

None given.

10.2 Quality Assessment

None given.

10.2.1 Data Validation by Source
Data have been reviewed by TF-01 personnel.

10.2.2 Confidence Level/Accuracy Judgment
None given.

10.2.3 Measurement Error for Parameters
None given.

10.2.4 Additional Quality Assessments
None given.

10.2.5 Data Verification by Data Center
The data were examined for general consistency and clarity.

11. Notes

11.1 Limitations of the Data
None given.

11.2 Known Problems with the Data
None given.

11.3 Usage Guidance
None given.

11.4 Other Relevant Information
None given.

12. Application of the Data Set

This data set can be used to study the soil properties of an aspen boreal forest.

13. Future Modifications and Plans

None given.

14. Software

14.1 Software Description
None given.

14.2 Software Access
None given.

15. Data Access

The SSA-OA soil characteristics data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

None given.

17.2 Journal Articles and Study Reports

Black, T.A, G. den Hartog, H.H. Neumann, P.D. Blanken, P.C. Yang, C. Russell, Z. Nesic, X. Lee, S.G. Chen, R. Staebler, and M.D. Novak. 1996. Annual cycles of water vapour and carbon dioxide fluxes in and above a boreal aspen forest. Global Change Biology 2: 219-229.

Blanken, P.D., T.A. Black, P.C. Yang, H.H. Neumann, Z. Nesic, R. Staebler, G. den Hartog, M.D. Novak, and X. Lee. 1997. Energy balance and canopy conductance of a boreal aspen forest: Partitioning overstory and understory components. Journal of Geophysical Research 102(D24): 28,915-28,927.

Chen, W.J., T.A. Black, P.C. Yang, A.G. Barr, H.H. Neumann, Z. Nesic, P.D. Blanken, M.D. Novak, J. Eley, R.J. Ketler, and R. Cuenca. 1999. Effects of climatic variability on the annual carbon sequestration by a boreal aspen forest. Global Change Biology 5: 41-53.

Fritschen, L.J. and L.W. Gay. 1979. Environmental Instrumentation. Springer-Verlag, Berlin, New York and Heidelberg.

Hook, W.R. and N.J. Livingston. 1996. Errors in converting time domain reflectometry measurements of propagation velocity to estimates of soil water content. Soil Science Society of America Journal. 60: 35-41.

Hook, W.R., N.J. Livingston, Z.J. Sun, and P.B. Hook. 1992. Remote diode shorting improves measurement of soil water by time domain reflectometry. Soil Science Society of America Journal 56: 1384-1391.

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Pearcy, R.W., J Ehleringer, H.A. Mooney, and P.W. Rundel. 1991. Plant physiological ecology: Field methods and instrumentation. Chapman and Hall, London and New York.

Russell, C.A. and R.P. Voroney. 1998. Carbon dioxide efflux from the floor of a boreal aspen forest. I. Relationship to environmental variables and estimates of C respired. Can. J. Soil Sci. 78:301-310.

Russell, C.A., R.P. Voroney, T.A. Black, P.D. Blanken, and P.C. Yang. 1998. Carbon dioxide efflux from the floor of a boreal aspen forest. II. Evaluation of methods - verification by infra-red analysis of a dynamic closed chamber. Can. J. Soil Sci. 78:311-316.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102(D24): 28,731-28,770.

Soil Classification Working Group (Eds.). 1998. The Canadian System of Soil Classification. 3rd Edition. Agriculture and Agri-Food Canada Publication 1646. National Resource Council of Canada Research Press. Ottawa, Ontario, Canada. 187 pp.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

E - Evapotranspiration.

F - Fibric: this is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

Fick's Law - This law states that the rate of diffusion, M, of one material through another is proportional to the cross sectional area of diffusion, A, the concentration gradient, dC/dX, and the diffusion coefficient, D. Their relationship is M = -D*A*(dC/dX).

H - Humus: this is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

L - Litter: this is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

LFH - The major organic horizons are L, F, and H, which consist mainly of forest litter at various stages of decomposition. These organic horizons developed primarily from leaves, twigs, woody materials, and a minor component of mosses under imperfectly to well-drained forest conditions.

19. List of Acronyms

```
AES      - Atmospheric Environmental Service
ASCII    - American Standard Code for Information Interchange
Batoche - The study site located in the Batoche National Historic Park
BFTCS    - Boreal Forest Transect Case Study
BOREAS   - BOReal Ecosystem-Atmosphere Study
BORIS    - BOREAS Information System
CD-ROM   - Compact Disk-Read-Only Memory
CFS      - Canadian Forest Service
DAAC     - Distributed Active Archive Center
DOY      - Julian Day of Year
EOS      - Earth Observing System
EOSDIS   - EOS Data and Information System
GIS      - Geographic Information System
GMT      - Greenwich Mean Time
GSFC     - Goddard Space Flight Center
HTML     - HyperText Markup Language
IFC      - Intensive Field Campaign
IRGA     - Infrared Gas Analyzer
NAD83    - North American Datum of 1983
NASA     - National Aeronautics and Space Administration
NEP      - Net Ecosystem Productivity
NOAA     - National Oceanic and Atmospheric Administration
NSA      - Northern Study Area
OA       - Old Aspen
ORNL     - Oak Ridge National Laboratory
PANP     - Prince Albert National Park
RSS      - Remote Sensing Science
S        - Sap Flux Density
SSA      - Southern Study Area
TDR      - Time Domain Reflectometry
TE       - Terrestrial Ecology
TF       - Tower Flux
URL      - Uniform Resource Locator
UTM      - Universal Transverse Mercator
```

20. Document Information

20.1 Document Revision Date

Written: 09-Jul-1999
Last Updated: 05-Nov-1999

20.2 Document Review Date(s)

BORIS Review: 21-Jul-1999
Science Review:

20.3 Document ID

20.4 Citation

When using these data, please acknowledge T. Andy Black and Z. Nesic of the University of British Columbia, and include citations of relevant papers in Section 17.2.

If using data from the BOREAS CD-ROM series, also reference the data as:

Black, T.A., "Boreal Forest Atmosphere Interactions: Exchanges of Energy, Water Vapor and Trace Gases (SSA-OA)." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

20.5 Document Curator

20.6 Document URL

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 2000	Technical Memorandum

4. TITLE AND SUBTITLE
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)
BOREAS TF-1 SSA-OA Soil Characteristics Data

5. FUNDING NUMBERS
923
RTOP: 923-462-33-01

6. AUTHOR(S)
T. Andrew Black, Z. Chen, and Zoran Nesic
Forrest G. Hall and Andrea Papagno, Editors

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS (ES)
Goddard Space Flight Center
Greenbelt, Maryland 20771

8. PEFORMING ORGANIZATION REPORT NUMBER
2000-03136-0

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS (ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
TM—2000–209891
Vol. 192

11. SUPPLEMENTARY NOTES
T.A. Black, Z. Chen, and Z. Nesic: University of British Columbia, Vancouver;
Andrea Papagno, Raytheon ITSS, NASA Goddard Space Flight Center, Greenbelt, Maryland

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Unclassified–Unlimited
Subject Category: 43
Report available from the NASA Center for AeroSpace Information,
7121 Standard Drive, Hanover, MD 21076-1320. (301) 621-0390.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The BOREAS TF-1 team collected several data sets in support of its efforts to characterize and interpret soil information at the SSA-OA tower site in 1994 as part of BOREAS. Data sets collected include soil respiration, temperature, moisture, and gravimetric data. The data are stored in tabular ASCII format.

14. SUBJECT TERMS
BOREAS, tower flux, soils data.

15. NUMBER OF PAGES
27

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL